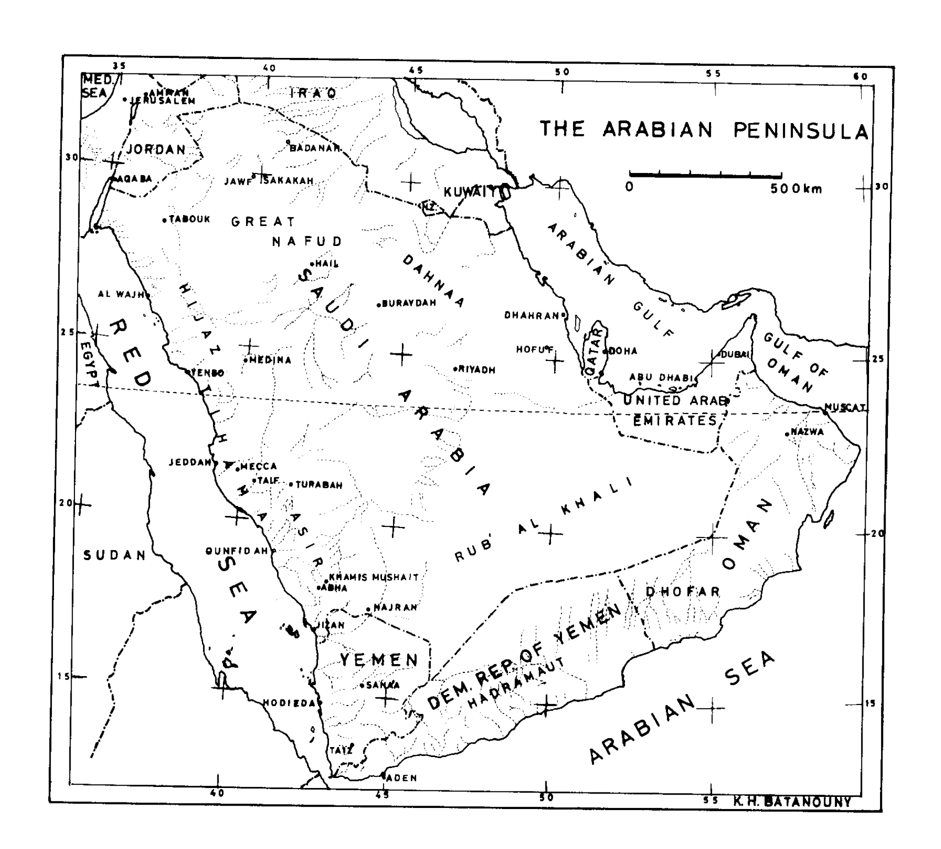
Natural History of Saudi Arabia: A Bibliography

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Map 1 — A Map Showing the Location of Saudi Arabia.

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FORWARD

The Kingdom of Saudi Arabia has witnessed, in the last decades, rapid socio-economic changes. The Government has accomplished vast undertakings in the various fields and is promoting the development of all the natural resources of the country. Realizing that education and scientific research represent the backbone of development, the Government has established uptil now six universities distributed all over the country. University members and graduates, participating in the progress of their country, have to carry out researches in the various fields. The country is endowed by innumerable natural resources which need development. This could be achieved properly by a thorough knowledge of basic scientific data of the ecosystem comprising the physical environment and plant and animal lives. It is a well-known fact that researchers need to be aquainted with previous studies in their fields. A bibliography covering the various biological aspects and the environmental features in the country may represent a starting point for much needed greater efforts in research in Saudi Arabia. Bibliographies, in general, compiled for various subjects have promoted the scientific activities and development programmes in the developed countries.

I believe that compilation of this bibliography is not an easy task. This is mainly due to the fact that many of what has been

written in these fields in Saudi Arabia are in the form of reports of limited distribution. That this bibliography is concerned with many subjects aggravates the problem.

Professor Dr. K.H. Batanouny has been engaged in compiling this bibliography since he joined the Department of Biology, Faculty of Science, King Abdulaziz University in September, 1975. That Professor Batanouny is well-informed about the various biological and environmental aspects in Saudi Arabia originates from his studies in the desert of different countries in the Middle East since 22 years. His publications, over 60, are pertinent to these subjects (see Appendix).

I am sure that this bibliography will be appreciated by his University Colleagues and students in Saudi Arabia, as well as researchers and organizations abroad. It is hoped that the present bibliography will be a great help in the furtherance of the study of the various branches covered by it.

Dr. Abdullah O. Nasseef
Vice-Rector
King Abdulaziz University

PREFACE

There is no doubt that the spectacular development of oil industry in Saudi Arabia caused a great change in the various socio-economic and cultural aspects in the country. However, Saudi Arabia is endowed with development potential outside oil, natural gas and their derivatives. The Government is exerting an impressive effort to develop other resources. In many fields, there is a noticeable growth, but greater potential. Surveys in the various fields of agriculture, water and mineral resources afford glimpses of great promise. However, the development of these natural resources and the discovery of new ones and new recourses combinations need extended scientific research activities. The present state of our knowledge in many fields is inadequate. It is indispensable to undertake studies in various fields as water resources, different patterns of land-use, grazing resources, irrigation methods, salinity problems, sand movement, vegetation, fauna, soils, climate and many other fields. For the achievement of these studies, it is necessary to be aquainted with the present state of knowledge in the field of study. Compilation of the publications, books and reports already written in the various subjects in Saudi Arabia is becoming increasingly important in view of the growing complexity of all scientific endeavor. This helps to review the present state of our knowledge and to analyse its elements.

The present bibliography covers different, but interrelated, subjects. It comprises six parts dealing with the environment, plant life, fauna, land-use, explorations and expeditions and various studies which are almost related to

the different fields covered by the bibliography. In every section of these parts, there is an introduction giving a framework of the available information in the concerned subject. As my researches and studies are closely related to the subjects dealt with in the bibliography, a chronologically arranged list of my publications is given in the appendix.

Dr. Iyad A. Nader, Chairman of the Department of Science and Math., College of Education, Abha, co-authored the section on the Fauna. Also, Dr. H.H. Hajrah, Chairman of the Biology Department, King Abdulaziz University, Jeddah, participated in the compilation of the reports of consultants submitted to the Ministry of Agriculture and Water.

The present bibliography could be looked upon as a step towards complete compilation with many additions in the future It is hoped that it will give a clear picture of the state of our knowledge of the concerned fields in Saudi Arabia. I feel that the next step is the preparation of an annotated bibliography on the different subjects.

K.H. BATANOUNY

Jeddah, Safar 21, 1398 A.H.

January 30, 1978 A.D.

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I would like to express my gratitude to Dr. M.O. Zobair, Rector, King Abdulaziz University, and Dr. Abdullah Nasseef, Vice-Rector, King Abdulaziz University, who provided me with the motivation to start this work.

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I wish to express my deep gratitude to Dr. Nabieh Baeshin who assisted me in every conceivable manner to have this bibliography published.

My sincers appreciation to all my colleagues in the Biology Department, in paricular Prof. Dr. M.A. Roshdy and Dr. A.A. Banajah for their help during the preparation of the bibliography.

Appreciation is also extended to Dr. A.A. Abu-Zinada, Chairman of the Biological Society of Saudi Arabia, who was keen on having this bibliography published and encouraged me to complete it.

Thanks are due to Dr. Jack Johnson and Miss Patricia Paylore of the Offiice of Arid Lands Studies, University of Arizona U.S.A. for providing me with lists of publications covering various fields in the Arabian Peninsula.

My thanks are due to Mr. Shawky S. Hamed for his efforts in typing the manuscript.

Finally, I wish to express my heartfelt thanks to my wife for her unrelenting support and for her patience, understanding and valuable assistance.

K.H. BATANOUNY

I — ENVIRONMENT

I — ENVIRONMENT

1. GEOMORPHOLOGY

Saudi Arabia extends over an area of some 2253000 sq. km, and occupies almost four-fifths of the Arabian Peninsula. The area occupied by the country represents about 1.5% of the total land area and 5% of the area of the arid zones in the world. The country extends between 16° and 32°N latitudes and 35° and 56°E longitudes. The kingdom is bounded on the north by the Hashemite kingdom of Jordan, Iraq and Kuwait; on the east by the Arabian Gulf, Qatar and the United Arab Emirates; on the southeast by Oman; and on the south by Yemen Arab Republic and People's Democratic Republic of Yemen.

Accurate topographical, geographical and geological maps and aerial photographs of Saudi Arabia have been prepared. However, proper geomorphological investigations are not abundant. The main geomorphological features of the country are : a) The narrow coastal belt along the Red Sea, known as Tihama, b) Hijaz and Asir mountains, which are composed of crystalline and metamorphic basement materials and volcanic rocks, c) The Arabian Shield extends nearly 800 km into north central Arabia but is relatively narrow at its both ends, d) Escarpments with steep westward-facing slopes and gentle eastern slopes, e) Great Nafud which is connected by the Dahna to the Rub' Al Khali, f) The eastern coastal zone (See map 1).

Perhaps the writings of the early travellers contribute to our knowledge of the geomorphology of the country. Among these travellers may be mentioned Musil (1926-1928), Thesiger (1946-1951) and Doughty (1964). Käselau (1928) provided qualitative descriptions of land forms in central and northern Arabia. Geomorphological features of western and central Arabia are described by Brown (1960). Holm (1953) described the dome-shaped dunes in Nejd and gave in 1960 a brief outline of the general geomorphic features of Saudi Arabia. He has shown that 30% of the country's surface is covered by sand, which occupies areas of low relief. The works of Bagnold (1951), Holm (1953), Musil (1926 to 1928), Phillips (1882), Thesiger (1946 to 1959) and Yarham (1958) devoted considerable attention to the dunes and sandy areas in the peninsula.

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2. CLIMATE

The climatological data in the country are too scarse to provide us with a clear picture of the various climatic factors. The Climatic Section, Meteorological Department is keeping a meteorological record for some stations since few years. These stations are located in airports and the collected data are not compiled into climatological normals. A meteorological record has been kept at Dhahran since 1935. The Hydrology Division, Ministry of Agriculture and Water is recording the rainfall peculiarities in many stations in different parts of the country since 1966. Recently, Al-Shalash (1973) compiled a rainfall atlas for Saudi Arabia depending on these data.

According to its geographical position and vegetation, Saudi Arabia comprises a tropical and an extratropical province. The former is governed by two climatic variants: Nubian and Ethiopian. The coastal Tihama, which is the hottest and driest area of south-western Arabia, represents the Nubian-desert climatic pattern, while the highland with its rather heavy rainfall represents the Ethiopian type. These south-western highlands have three rainy periods : summer monsoon rains, winter rains brought by cyclonic rains supplemented by rains brought by southerly winds blowing up the Red Sea against Asir mountains, and the early summer rains in the nature of heavy local thunderstorms. The northern part of the country is governed by winter rains, while the Rub' Al-Khali (Empty Quarter) is included within the regime of summer rains. However, rainfall in the Rub' Al-Khali is sporadic.

Apart from the highlands in the south-western part of the country with relatively abundant rains, the rainfall is scanty all over the whole country and rarely exceeds an annual mean of 100 mm. The highest rainfall in Saudi Arabia is recorded in Jebel Salah (17° 03' N, 43° 07' E); an average of 13 years was found to be 563.7 mm/year (Al-Shalash, 1973). At Taif airport (21° 29' N, 40° 22' E) to the north of the south-western highlands, the average rainfall is 153 mm/year. In Tihama the rainfall is low; the annual average rainfall at stations in this area from north to south is 22.6 mm at Al-Wajh, 78.2 mm at Umm Lajj, 19.4 mm at Yenbou, 13.3 mm at Rabigh, 79.8 mm at Jeddah, 79.5 at Al-Lith, and 30.5 mm at Jizan.

In the plateau to the east of the southwestern highlands, the rainfall becomes lower than in the mountains with an annual average of 224.6 mm at Khamis Mushait, 145.3 mm at Bisha, 98.4 mm at Turaba, while it is only 43.1 mm at Najran. Northwards at Medina, the rainfall is 47.2 mm/year and at Tabuk it reaches 65 mm/year.

In the northern part of the country the rainfall is 30 mm/year (Badana, Al-Isawiah and Turaif), but increases to 69.7 mm/year at Sakaka. In the eastern part of the country, the average rainfall at Dhahran, 18 years period, amounts to 72.7 mm/year, with a range between 16.8 and 172.3 mm.

In the central part of the country, Riyadh has an annual average of 100.2 mm (20 years).

Generally, rainfall in Saudi Arabia is characterized by scantiness and variability in time and space. One of its main characteristics is the occurrence of heavy sporadic rains of local nature. These rains are usually due to thunderstorms and apt to cause severe torrents.

In many parts of the country, temperatures are extremely high during the summer months. Temperatures over 38°C occur for weeks, with frequent days over 45°C and occasionally over 50°C. The winters, particularly to the north, are characterized by a few nights below freezing and day-time temperatures as high as 25°C.

Humidity is high on coasts of the Red Sea and the Arabian Gulf and low inland.

The list of publications dealing with the climate of Saudi Arabia evince that the climate of the country must await detailed study. During their studies on water resources, the consultants contarcted with the Government of Saudi Arabia gathered numerous climatological data in the different localities under study (*cf.* Reports submitted by various consultants to the Ministry of Agriculture and Water). It is hoped that the climatological data obtained by the various Governmental Departments and other bodies are compiled together. This will certainly give an instructive and useful climatic study.

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3. WATER RESOURCES

The country is devoid of perennial streams, however local floods usually occur. Due to the scantiness and irregularity of rainfall, the resulting runoff is irregular. Generally, underground water reserves are larger and more reliable. In the past these groundwaters have nurtured the oases and towns. Recent water recources studies have located many aquifers with large amount of stored water. Hasty drilling replaced the hand-dug wells; a process that caused uncontrolled extraction which created many new problems affecting the productivity of the agricultural lands. For civic uses, desalinization plants have been established in 6 cities along the Red Sea and the Arabian Gulf coasts. Numerous dams in the different parts of the country have been constructed for water reservation. The greatest dam is that of the Wadi Jizan.

Despite the numerous achievements in the field of water resources development in Saudi Arabia,, the continuous increasing demand for various purposes is still imposing many problems. Saudi Arabia represents a unique case due to many factors pertinent to the development of water resources. Some of these factors impose problems, while others offer prospects of water development in the country. These factors may be related to the physical feaures of the country and its environment, e.g. vast area of the country, long shores along the Red Sea and the Arabian Gulf, different geological and geomorphological features, extremely harsh climatic conditions, and the deficiency of water resources. Other factors are relevant to the socio-economy of the country, e.g. high oil revenues and the consequent rapid socia-economic changes; combined with the lack of manpower in many fields. The present knowledge of the water resources in the country and the factors involved in the problem does not fulfil the requirements for integrated development planning.

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4. MAN AND ENVIRONMENT

Due to the vast undertakings in the fields of health, education, communications, housing, agricultural improvement, development of water supplies, the man-environment relationships have become of crucial importance in Saudi Arabia. Since the first commercial quantities of oil were discovered near Dammam in 1938, technological society has impigned increasingly on the ecosystem. The ever-changing landscape, as a result of oil fields, road-construction, housing and industrialization, exhibits how far it is important to study the relationships of man and his environment in Saudi Arabia. The human impact in the different parts of the country is very prominent with man-induced hazards. Wealth accuring from oil exploitation has its clear effect on different aspects of the man and his environemnt.

The nomad problem, deterioration of the ranges, salinization of the irrigated land, overwhelming of the oases by aeolian sand, and extravagant use of water supplies are problems that deserve rapid solution. This may be achieved by better understanding the physical environment as well as the man-environment relationships. Despite the importance of such studies they are fragmentary.

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II — PLANT LIFE

II — PLANT LIFE

1. FLORA AND VEGETATION

Our present knowledge of the flora of Saudi Arabia is still incomplete, but not so meagre as is commonly believed. Numerous collections, mainly from the tropical south of the peninsula, are deposited in many herbaria in Europe, Plant collections from the northern extratropical part of the peninsula are few.

The principal sources or our knoweldge of the flora of the Saudi Arabia are :

Forsskal (1775), Vahl (1790-1794), Fresnius (1834), Decaisne (1834-35, 1841), Kotschy (1866), Deflers (1889, 1894), Baker (1894), Schweinfurth (1894-99), Krause (1905), Vierhapper (1907), Carter (1917), Blatter (1919-36), Schwartz (1934, 1939), O. Dickson (1938), Brutt *et al.* (1949-54), V. Dickson (1955), Zohary (1957), Khattab and El-Hadidy (1971), Migahid and Hammouda (1974), and De Marco and Dinelli (1974).

The flora compiled by Blatter (1919-36) is a cursory, non critical compilation, but with a review of all botanical explorations in the Arabian Peninsula. The Flora of Schwartz (1939) is a valuable work, but it is limited to Tropical Arabia. The recent Flora of Saudi Arabia compiled by Migahid and Hammouda (1974) comprises plants from the whole country. It covers almost 1000 species belonging to about 500 genera in 94 families. Keys to the families and the genera are presented in this flora.

The monumental work "Flora Orientalis" of Boissier (1867-1888) represents the principal source of knowledge on the floras of many countries of the Middle East including Saudi Arabia. It has been published in five volumes (1867-1884) and a supplementary volume (1888). These volumes are based not only on Boissier's own collections from the Middle East countries, but also on those of many other collectors. This flora is outstanding for its meticulous examinations and exact descriptions.

One great contribution to our knowledge of the flora of Saudi Arabia is that made by locust surveys. In 1944-1945, the Egyptian anti-locust unit crossed Hijaz and Yemen. During these expeditions, a collection of about 6000 specimens, representing over 750 species, was brought back to Cairo and deposited in the Agricultural Museum. Also, duplicate series were deposited in "Conservatoire Botanique" in Geneva and in the Herbarium of the Faculty of Science, Cairo University. The collection was revised recently and a list of 700 species was published by Khattab and El-Hadidy (1971).

The scientific staff of the Middle East anti-locust unit collected many plants during their expeditions (1942-1945) and the collections have been deposited in the British Museum (Natural history). A list of 213 species was published by Zohary (1957). The same author wrote about "Al Ghada" tree in Arabia (1940). His book "Geobotanical foundations of the Middle East" in 1973 gives accounts of the flora and the available information about the vegetation of Saudi Arabia.

With respect to the vegetation study in Saudi Arabia, the available investigations are very rare. Uptill now, our knowledge of the plant communities and their habitat features is fragmentary. It is noteworthy to know that the first account of the vegetation in the whole peninsula is that of Deflers (1889). This work deals with the geobotany of the tropical part of the peninsula and Yemen.

The outline of the vegetation for the western coast, central and eastern parts of the country is given by the very instructive work of Vesey-Fitzgerald (1955, 1957 a & b). In addition to the great value of these papers from the phytosociological point of view, they contribute to our knowledge of the flora of Saudi Arabia.

The FAO locust expeditions resulted in a great deal of reports on the flora, vegetation and the environmental conditions. Among these reports may be mentioned those of Popov and Zeller (1963) and Popov (1965). The same holds true with the reports of the agricultural missions and those concerned with grazing resources.

Recently, Giacomini and De Marco (1974) gave a paper on the vegetation of some parts of the country and De Marco and Dinelli (1974) gave a list of 1211 species and subspecies belonging to 537 genera and 112 families.

Batanouny (1978) in his study on the rangelands of the Arabian peninsula, gives a brief description of 70 plant communities in the region. This is the first attempt to compile the available information with the field studies of the author on the vegetalion of the peninsula. The same author (1978b) gives a study on the vegetation along Jeddah-Mecca road. In the latter study, he described 12 plant communities in the area and recorded 86 species; four of which are new records to the flora of Saudi Arabia.

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2. LOWER PLANTS

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III — FAUNA

III- FAUNA

K.H. BATANOUNY and I.A. NADER

The present state of knowledge of the fauna of Saudi Arabia is inadequate. No ecological or geographical study of the animals roaming the deserts or the highlands has been carried out, and the zoological knowledge is spotty both biologically and geographically. Perhaps locust has received a considerable attention as compared to other groups of the fauna of the country. However, these studies are not listed in our bibliography.

Check-lists are available for agricultural pests, other insects, snakes, birds and a few amphibians. A considerable account of the mammals has been given by Harrison (1964-72). Arachnids, crustaceans and snails of Saudi Arabia have not been studied.

Faunal information may be found in the writings of the travellers crossing the peninsula. Lists of some animals are given in many of these writings, therefore they are included in the bibliography on the fauna of the country.

The Saudi Arabian Natural History Society at Jeddah issues a quarterly journal. Articles published in this journal are very instructive and contribute, to a great measure, to our knowledge of the fauna of the country. The groups receiving more attention are the birds and reptiles, especially snakes.

The invertebrate fauna is not well-known in the country This is evident from the limited number of references listed in the bibliography dealing with invertebrates. Insects received relatively more attention than other groups. Publications concerned with all the invertebrates are listed under one heading.

The vertebrate fauna is relatively better known than invertebrates in the country. The bibliography on vertebrate fauna is divided into three sections : Amphibia and Reptiles, Birds and Mammals. The part dealing with the vertebrates does not include any references on fishes since this group does not restrict itself to one country's territorial water. It is hoped that in the future there will be special publications on the fauna of the Red Sea and the Arabian Gulf.

The Kinds of snakes and their geographic distribution in the Kingdom are considerably well demonstrated. The writings of Gasperetti (1974-1977) contributed greatly in this respect. Other reptiles are not well-known and await surveys and studies.

As for the section on the birds, it is not as complete as it should be since we know that Major W.A.C. Griffiths has published in 1975 a bibliography on the avifauna of the whole Arabian peninsula, Levant, and Mesopotamia. This will be of more value to the ornithologists interested in the whole area.

Many lists of birds are published in the Journal of the Saudi Arabian Natural History Society. The articles are given by bird watchers. Numerous migratory birds pass over the country. Eagies, hawks, falcons, vultures, owls, ravens, fllamingoes, egrets and pelicans are common in Arabia. Migratory birds as cuckoos, thrushes, warblers, swallows and wagtails are seasonally common. Falconary is a famous sport in Arabia. The falcons, after laborious training, are used for hunting Macqueen's bustard (hobara). Other game birds are the sandgrouse (qata), the stone curlew (karawan), doves, quail and the portridge (daraja).

The Syrian ostrich(*Struthio camelus syriacus*) has become extinct in Arabia in recent years. One of the last on record was shot near the Iraq boundary in 1938.

The extermination of different species of gazelles by hunting parties in trucks and cars is evident in many parts of the country. The Arabian Oryx(*Oryx leuroryx*) is almost extinct. It is hoped that the establishment of national parks in Saudi Arabia will help to preserve the gazelles (*Gazello Gazella, G. Sybgutturosa*) and the ibex (*Capra ibex*)

The present bibliography shows that there is a wide gap in the present knowledge of the ecology, eco-physiology and other subjects concerned with the animal life in Saudi Arabia.

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IV — LAND USE

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1. RANGE RESOURCES

The range livestock industry has played an important economic role in the history of Saudi Arabia. Although the relatively recent discovery of oil has given the kingdom a new source of income to bolster its economy, range and livestock has and will continue to be highly important in the economic structures of the country.

The Bedouin and his sheep, camels, and goats have roamed the Arabian Peninsula for centuries utilizing the sparse forage. The immemorial grazing lands in Saudi Arabia, which have supported a hardy race of pastoralists for hundreds of years, face certain extinction unless immediate steps are taken to halt the destruction of the perennial range plants before they are destroyed by overgrazing, fuel gathering and shifting cultivation.

Despite the importance of the grazing land; occupying 210 million hectares compared to 400 700 hectares of land being farmed, the studies dealing with rangeland and grazing resources are mainly in the form of reports of limited distribution. No quantitative studies have been carried out. The book written by Allred (1968) contributes to our knowledge of the rangeland in Saudi Arabia. It has been translated to Arabic and published by the Ministry of Agriculture and Water. It comprises valuable information on the grazing resources in Saudi Arabia, methods of study of range potentialities and a list of 600 native and introduced plants. However, the book written by Draz (1965) in Arabic gives instructive information on range land in the country. The author is the first who discusses the Hema (reserve) system.

Batanouny (1978) gives all the available information and data on the rangelands of the Arabian Peninsula, in addition to the data collected by him from the various countries of the region. In this study, he discusses the envionment, vegetation, the key range species as well as the productivity, management and development of the rangelands in the peninsula.

Generally, the implementation of satisfactory range management programme is hampered by the lack of technicians trained in this field, lack of appreciation of the basic principles of range management by the livestock owners, the limited availability of watering points, and the migration of livestock from neighbouring countries.

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2. AGRICULTURE AND RELATED SUBJECTS

Traditionally agriculture in Saudi Arabia has been centered around oases and wadi channels scattered throughout the Kingdom where springs and shallow ground water are available or where rainfall alone is sufficient for the cultivation of crops such as wheat, barley, millet and some vegetables and fruits (for example, the Asir region where the annual rainfall exceeds 300 mm) (El-Khatib, 1974). The latter author (1974) states that the cultivated area amounts to 385219 hectares, comprising 33000 ha rain fed and 101000 ha under flood irrigation. However, the surveys carried by consultants in six regions of the Kingdom (1,281,000 sq.km.) show that the total cultivable land has an area of 4.171,557 ha comprising 595807 ha of arable land with various suitability classes and 3,575,750 ha of arable lands which require classification. Many wadis in Saudi Arabia offer good prospects for agricultural development due to the availability of good water and good arable lands.

Since more than 40 years, agricultural missions began to undertake their studies on the land and water resources. Food and Agriculture Organization of the United Nations (FAO) experts provided the Government with many reports resulting from different surveys. For the excution of the various agricultural development projects, the Ministry of Agriculture and Water contracted with many international consultants and scientific organizations to carry out various studies dealing with soil, water resources, agricultural potentialities... etc. Studies of the researchers in the Ministry of Agricultura and Water and the staff-members in the universities contribute to our knowledge of agriculture and related problems.

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3. PUBLICATIONS OF THE ANIMAL PRODUCTION AND AGRICULTURAL RESEARCH CENTRE-HOFUF

Joint research at the Animal Production and Agricultural Research Centre, Hofuf started after signing an agreement in 1970 between the Ministry of Agriculture and Water of Saudi Arabia and the University College of North Wales (UCNW), Bangor. The primary objective is to improve livestock production techniques on irrigated land, and in particular to produce cows milk and sheep meat effiiciently. Also, an essential complementary objective is to investigate forage crops.

The results of some experiments have been printed at UCNW Bangor as Publications of University College North Wales and Ministry of Agriculture and Water, Saudi Arabia, Joint Agriculture Research and Development Project. A list of these publications is given below.

1. **Farnworth, J.** and **W.I. Robinson**
   1972 A review of research on animal and forage production in Saudi Arabia. 23 p.
2. **Al-Noaim, A.** and **J. Farnworth**
   1972 The effect of nitrogen on the early growth of a crop of alfalfa and wheat. 5 p.
3. **Ramadan, M.Y.** and **W.I. Robinson**
   1972 Growth rates and voluntary feed intakes of Najdi ram lambs, fed on alfalfa. 6 p.
4. **Farnworth, J.**
   1972 A trial of introduced forage crops. 11 p.
5. ————
   1972 The effect of seed rate on the forage yield of Delta barley. 5 p.
6. **Cresswell, E.** and **W.I. Robinson**
   1972 A simple yard and parlour system for milking cows. 3 p.
7. **Robinson, W.I.** and **I. Shaabi**
   1972 A study of the performance of Najdi and Awassi lambs.
8. **Ramadan, M.Y.** and **W.I. Robinson**
   1972 Digestibilities of green forages by sheep. 6 p.

9. **Farnworth, J., A. El Naoim** and **O. Duheash**
1972 The effect of rate of nitrogen application on yields of barley and maize as winter forages in Saudi Arabia. 8 p.

10. **Farnworth, J.**
1973 A trial of introduced and local forage species as pioneer crops for winter land reclamation at Hofuf, Saudi Arabia. 15 p.

11. **Al Naoim, A.** and **J. Farnworth**
1973 Observations on the growth over one year of Hasawi alfalfa grown under irrigation in Saudi Arabia. 12 p.

12. ——————
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13. **Farnworth, J.** and **I.B. Ruxton**
1973 A comparison of hasawi alfalfa with five imported varieties. 6 p.

14. **Farnworth, J.**
1973 The effect of nitrogen, phosphate and potash fertilizer levels on the yield of of forage sorghum, var. beefbuilder., grown in the Al-Hassa oasis. 10 p.

15. **Sekan, A., A. Al Noaim** and **J. Farnworth**
The growth of mangels and fodder beet under four contrasting fertilizer regime. 8 p.

16. **Farnworth, J.**
1973 Effect of cutting frequency on hasawi alfalfa.

17. **Farnworth, J.** and **I.B. Ruxton**
1973 The response of forage sorghum to applications of nitrogen and iron chelate.

18. **Halfpenny, A.F.** and **O. Duheash**
1973 Some relationships between soil conditions and the establishment and chemical composition of alfalfa grown on newly reclaimed land at the Hofuf Research Centre. 12 p.

19. **Farnworth, J.** and **J.B. Ruxton**
1973 Comparison of graminaceous forage crops and Hasawi alfalfa for summer reclamation of heavy saline soils at Hofuf. 12 p.

20. **Sekan, A., A. Al Noaim** and **J. Farnworth**
1973 A comparison of five cereal species grown for winter forage on established land and as pioneer crops at the Hofuf Research Centre. 9 p.

21. **Farnworth, J.** and **I.B. Ruxton**
1973 A comparison of some cereal species and varieties for autumn sown forage production at the Hofuf Research Centre. 15 p.

22. **Halfpenny, A.F., J. Farnworth** and **O. Duheash**
1973 Further observations on the relationships between soil gypsum content and the establishment and growth of crops on newly reclaimed land at the Hofuf Research Centre. 12 p.

23. **Ramadan, M.** and **W.I. Robinson**
1973 The performance of black Najdi lambs on diets containing date molasses. 9 p.

24. **Farnworth, J., Halfpenny, A.F.** and **W.I. Robinson**
1973 A survey of Hofuf oasis farmers. 5 p.

25. **Robinson, W.I.** and **C.J.R. Pritchard**
1973 A comparison of milk allowances, with alfalfa and with or without barley, for rearing Jersy calves in Saudi Arabia. 11 p.

26. **Pritchard, C.J.R.** and **I.B. Ruxton**
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27. **Robinson, W.I.** and **C.J.R. Pritchard**
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28. **Ramadan, Y.M.**
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29. **Robson, A.L., J. Farnworth** and **I.B. Ruxton**
1974 A note on midsummer regrowth of Hasawi alfalfa and Rhodes grass (c.v. Katamborn) grown under irrigation in Saudi Arabia. 8 p.

30. **Ruxton, I.B.** and **O. Duheash**
1974 Methods of analysis in use at the Hofuf animal production and research Centre Saudi Arabia. I. Routine analysis of forages and soils. 21 p.

30. **Farnworth, J.** and **I.B. Ruxton**
1974 The effect of subsoiling and the application of cow yard manure on a pioneer barley crop followed by alfalfa in reclaiming saline desert at Hofuf, Saudi Arabia. 11 p.

32. **Halfpenny, A.F., J. Farnworth** and **O. Duheash**
1974 The effect of sand, copper and molybdenum applied to virgin desert land cropped under irrigation with forage barley and alfalfa. 13 p.

33. **Davies, G.M.** and **J. Farnworth**
1974 The effect of varying seed rates of alfalfa and barley grown in mixtures over a one year period. 12 p.

34. **Shears, P., M.R. Chegwin** and **J. Farnworth**
1974 Approaches to improved water management at the Hofuf animal production and agricultural research centre. 23 p.

35. **Farnworth, J.**
1974 A preliminary study on the effect of shelter on alfalfa and Rhodes grass grown under irrigated arid zone conditions in Saudi Arabia. 10 p.

36. **Farnworth, J., A. Al Noaim** and **I.B. Ruxton**
1974 The response of Hasawi alfalfa to nitrogen application when grown under irrigation in Saudi Arabia. 9 p.

37. **Farnworth, J. and I.B. Ruxton**
1974 The effect of nitrogen on the productivity and composition of Rhodes grass (var. Katamborn) grown under irrigated arid zone conditions. 15 p.

38. ——————
1974 A comparison of graminaceous forage species sown in mid-summer for saline soil reclamation under irrigated arid zone conditions. 11 p.

39. **Farnworth, J.**
1974 A trial of introduced and local forage species as pioneer crops for summer reclamation of sandy, saline, high carbonate soil at Hofuf, Saudi Arabia. 9 p.

40. **Farnworth, J.** and **I.B. Ruxton**
1974 The effect of varying rates of phosphate application on the productivity and composition of Hasawi alfalfa grown in irrigated arid zone conditions. 16 p.

41. ——————
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42. ——————
1974 A preliminary study on the growth and composition of Hasawi alfalfa and Rhodes grass (c.v. Katamborn) grown in pure stands and mixtures under irrigated arid zone conditions. 13 p.

43. ——————
1974 The effect of nitrogen and phosphate on yield and composition of forage millet grown as a reclamation crop under irrigated arid zone conditions. 15 p.

44. ——————
1974 The effect of rate of nitrogen application on three consecutive crops of forage maize grown in one season under irrigation at El Hassa, Saudi Arabia, 10 p.

45. ——————
1974 The effect of phosphate application on yield and composition of forage barley and sorghum grown as reclamation crops in irrigated arid zone conditions. 9 p.

46. ——————
1974 Studies on the effect of calcium carbonate and gypsum on yield and composition of forage barley and sorghum grown as reclamation crops when applied to virgin soil in an irrigated arid zone situation. 15 p.

47. **Farnworth, J., P. Shears** and **I.B. Ruxton**
1974 A study of the effect of water application rate on a pioneer crop of forage barley followed by sorghum or millet and finally alfalfa in saline arid zone conditions. 18 p.

48. **Farnworth, H., I.B. Ruxton** and **D. Younie**
1974 A comparison of winter pioneer forage crops for the reclamation of sandy calcareous soil at Hofuf, Saudi Arabia. 9 p.

49. ——————
1974 The response to nitrogen of oats grown for winter forage and the reclamation of heavy saline desert soil in Saudi Arabia. 8 p.

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51. **Farnworth, J.**
1974 Machinery for intensive arid zone forage and animal producduction at Hofuf, Saudi Arabia. 44 p.

52. **Farnworth, J., A. Al-Noaim** and **I.B. Ruxton**
1974 The response of Sudan grass to application of triple super phosphate at the Hofuf animal production and agricultural reserach centre. 9.

53. **Farnworth, J., C.J.R. Pritchard** and **I.B. Ruxton**
1974 A comparison of six systems for producing barley forage and grain. 8 p.

54. **Bloomfield, J.R.G.**
1975 Observations on the use of dalapon for the control of *Phragmites australis* (Cav.) Trin. ex Steud. in Saudi Arabia. 6 p.

55. ———
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57. ———
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59. **Ruxton, I.B.**
1975 A preliminary report on the proximate composition of forage grown at the animal production and agricultural research centre, Hofuf, Saudi Arabia. 12 p.

60. **Pritchard, C.J.R.**
1975 A note on the characteristics and performance of native Zebu cattle at the Hofuf agricultural research centre. 12 p. + App.

61. **Pritchard, C.J.R., Ann E. Penell** and **G.L. Williams**
1975 A note on the wool characteristics of sheep at the Hofuf agricultural research centre. 9 p.

62. **Jones, R.G. Wyn** and **J. Farnworth**
1975 Observations on a crop of chlorotic maize at Hofuf. 14 p.

63. **Chamberlain, A.G.**
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64. **Stewart-Jones, W.**

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66. **Jenkins, David A.**

1975 Observations on the soils of the agricultural research centre, Hofuf, 30 p.

67. **Pritchard, C.J.R.** and **I.B. Ruxton**

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68. **Younie, D., J. Farnworth,** and **I.B. Ruxton**

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69. **Younie, D.**

1975 Effect of seed rate and nitrogen application rate on yield and composition of forage oats grown after alfalfa. 9 p.

70. **Younie, D.**

1975 A comparison of temperate cereal species for use in mixed stands for forage production at Hofuf, Saudi Arabia. 7 p.

71. **Brown, W., J. Farworth** and **S.H. Clarke**

1975 A feasibility study of three farming types in Saudi Arabia. 1. Forage production for sale. 9 p.

72. ——————

1975 A feasibility study of three farming types in Saudi Arabia. 2. 100 cow dairy farm. 14 p.

73. ——————

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74. **Pritchard, C.J.R.**

1975 A preliminary investigation of the potential of Rhodes grass (*Chloris guyana*) for growing lambs under an intensive grazing system. 7 p.

75. **Farnworth, J.**
1975 A comparison of twenty-four legume varieties at Hofuf agricultural research centre, Saudi Arabia. 5 p.

76. ———————
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80. ———————
1976 A comparison of forty-seven alfalfa varieties grown with irrigation at Hofuf, Saudi Arabia. 5 p.

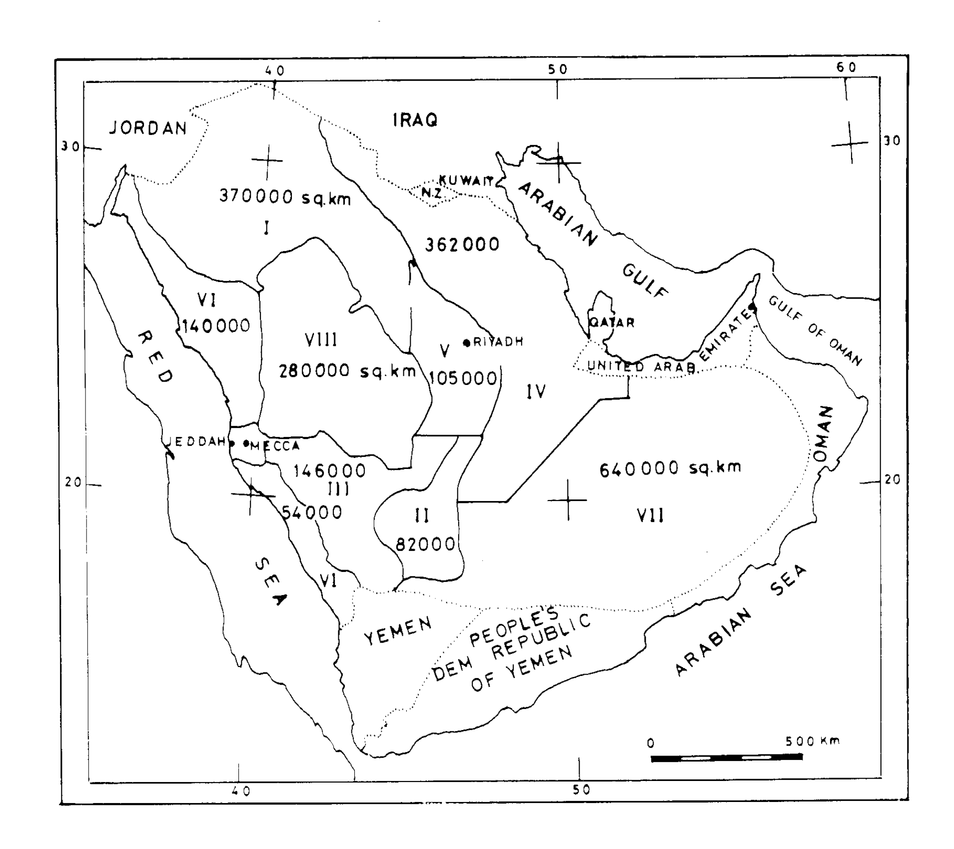
81. **Farnworth, J.** and **R.J. William**
1976 The effect of saline drainage or well water on the productivity of six summer sown crops. 9 p.

Robinson, W.I. and **I.A.M. Lucas**
1974 Diets based on lucerne, ground whole dates, concentrates and dried fish for Jersy cows, castrates and bulls. Trop. Agric. (Trinidad) 51 (1) : 43-49.

4. PUBLICATIONS ON IRRIGATED AGRICULTURE AT AL-HASSA

An agrement was signed in September, 1967 between the Ministry of Agriculture and Water and the Leichtweiss Institute for Water Research at the Technical University Braunschweig to undertake cooperative research on irrigated agriculture under the soil and climatic conditions of the Al-Hassa Oasis. Since 1968, data collection and experimental work started. The accumulated data and information have been compiled in many reports, which have been submitted to the Ministry of Agriculture and Water in Riyadh. The publications and technical reports are given in the following list.

1. Publication No. 1 : Situation of the irrigated agriculture in the Eastern Province of Saudi Arabia, October 1968.
2. Technical report about the research work till 1st September 1969 in the Al Hassa Region, March 1970.
3. Second technical report about the research work in the Al-Hassa Region from 1st September 1969 till 30th September 1970 (1 Vol. reports, 1 Vol. Appendices), Spring 1971.
4. Publication No. 2 : General information about the team, the research facilities and the stage of the work in Spring 1972, March 1972.
5. Publication No. 3 : Percolation losses — irrigation with oasis environment — water measurements — evapotranspiration — fixation of of shifting sand dunes, April 1972.
6. Publication No. 4 : Leaching requirement for soil reclamation, June 1972.
7. Publication No. 5 : Leaching requirement for permanent salinity control of cropped soils, December 1972.
8. Publication No. 6 : Properties of soil and water in the Hofuf Agricultural Centre, March 1973.
9. Publication No. 7 : Agrometeorogical data of the Al-Hassa Oasis, June 1973.
10. Publication No. 8 : Consumptive use of alfalfa in the Al-Hassa region, September 1973.
11. Publication No. 9 : Furrow irrigation in the Al-Hassa Oasis, March 1974.
12. Publication No. 10 : Preliminary results on the re-use of drainage water for irrigation, June 1974.
13. Publication No. 11 : Experiments on border strip irrigation in the Al Hassa Oasis, December 1974.
14. Publication No. 12 : Basin irrigation experiments in the Al Hassa Oasis, May 1975.



Map 2 — A map showing the division of Saudi Arabia into eight areas for implementation of hydro-agricultural surveys.

5. PEPORTS PREPARED BY CONSULTANTS

By

K.H. BATANOUNY and H.H. HAJRAH

The Ministry of Agriculture and Water in 1964 initiated vast programmes toward the improvement and expansion of agriculture. The country was divided into eight areas with boundaries based on both hydrological and topographical features for implementation of hydro-agricultural surveys (See map 2). By 1970, six out of the eight areas has been surveyed, covering some 1,281,000 sq.km., which is equivalent to about 55% of the total area of the country. The still unserveyed areas are : area VII, the Rub Al Khali (640,000 sq.km.) and area VIII in the centre of the country (280,000 sq.km.). The cost budgeted for these surveyes at that time was in the order of the equivalent of 28 million US Dollars. Contracts to carry out hydroagricultural surveys in the six areas were awarded to the international consultants : Parsons Basil (Area I), Italconsult (Areas II, III, IV and Jeddah-Mecca-Taif area), and Sogreah (Areas V and VI).

The purpose and scope of these hydro-agricultural surveys are generally : a) to survey water resources, both surface and groundwater, their quality, quantity and locality; b) to survey land and range potentialities, c) to suggest ways and means of improving the living conditions of the rural population and the settlement of nomads through the provision of better opportunities in the form of more water and land to increase agricultural production and through adoption of modern agricultural techniques.

The results obtained from thse surveys are embodied in many reports. The data were summarized and evaluated by Standford Research Institute (1971). In 1974, the Ministry of Agriculture and Water published a book prepared by A.B. El-Khatib comprising a summary of the hydro-agricultural surveys in the country.

Generally, the reports submitted by different consultants and organizations to the Ministry of Agriculture and Water contain very instructive information on topography, climate, hydrology, hydrogeology, soil, agriculture, grazing resources, stockraising and many other subjects.

A) Reports Prepared by ITALCONSULT

I- Land and Water Surveys on the Wadi Jizan
(U.N. Special Fund Project-Excuting Agency FAO)
June, 1965

Vol. I : General Report
- — Conclusion of the study
- — Appendix 1 : Activities carried out
- — Appendix 2 : Topographic report
- — Appendix 3 : Preliminary study of the Malaki dam for the regulation of the wadi Jizan
- — Appendix 4 : Guidelines for the rational ization of the irrigation system in the wadi Jizan.

Vol. II : Hydrological Report
Vol. III : Agronomic Report
Vol. IV : Socio-economic Report, with appendices
Vol. V : Geological Report
Vol. V : Ground water Report
Vol. VII : Geoelectrical Report

II- The southern Jabal Tuwaiq (Area II) and Asir Area (Area III) :
December, 1965 :

Water and agricultural development surveys for areas II and III. Programme of work and budget report.

A planning and cost survey to define the programme of work and the methods to be followed in the excution of the studies for areas II and III.
February, 1969

a) **Final Report :** summarizes the main conclusions on investigations performed and lays down the essential features of the suggested guidelines for Government activity in the next ten years.

b) **Water Development Reports :** including the following specific reports :
1. Mapping and topography
2. Climate and surface hydrology
3. Water inventory
4. Geological investigations
5. Geophysical investigations
6. Drilling investigations
7. Discharge tests

c) **Agricultural Development Reports** : including the following specific reports :

1. Land inventory
2. Grazing resources inventory
3. Stockraising
4. Crops and farming techniques
5. Agriculture and pastoralism

d) **Reports on Wadi Dawasir Pilot Project**

1. Geohydrological investigations
2. Soil surveys and maps at 1 : 60,000
3. Agriculture and human resources
4. Pilot project-Feasibility study

e) **Reports on Wadi Bisha Pilot Project**

1. Geohydrological investigations
2. Soil survey and maps
3. Agriculture and human resources
4. Pilot project-Feasibility study

III- Jeddah-Mecca-Taif area

February, 1969

a) **Final Report**

b) **Specific Reports** : including the following :

1. Surface morphology, mapping and topographic maps
2. Hydrologic and climate investigations
3. Geologic investigations
4. Groundwater investigations (Four volumes)
5. Geophysical investigations.
6. Drilling investigations (Two volumes)
7. Surface and groundwater development
8. Town water supplies : Present situation and demand
9. Agronomic investigations
10. Economic evaluation of agriculture

IV- The Eastern Region (Area IV)

November, 1969

a) **Final Report**

b) **Specific Reports,** including the following :

1. Mapping and topography
2. Climate and surface hydrology
3. Land inventory and drawings
4. Geohydrology Surveys :

Vol. I : Geological and geophysical
Vol. II : Groundwater development
5. Drilling investigations
6. Discharge tests
7. Water point inventory
8. Grazing resources inventory + Drawings (photos of many herbarium specimes)
9. Stockraising
10. Wadi Al Miyah soil survey
11. Al Hasa oasis irrigated agriculture

B) Reports Prepared by SOGREAH

I- Riyadh Area (Area V)

This set of reports comprise reports on some pilot projects and the final reports.

a) Pilot Projects

1. Al Aflaj pilot project (Feasibility report) July, 1967.
2. Al Kharaj pilot project. July, 1967.
3. Riyadh water supply — Summary of special reports. December, 1967.

b) Final Reports : December, 1968.

The final reports are composed of a parts in 10 volumes

1. **Findings and Recommendations** (Vol. 1)
   This report covers the following items :
   Brief description of area V — The need for investigation — General programme and work done — Summary of results — General conclusions and recommendations.
2. **Water Resources** : Text (Vol. 2)
   This report comprises the following sections and subsections :
   a) Introduction
   b) Hydroclimatology — Surface water resources — Meteorology and climatology — Overland runoff and surface water resources — Attempted determination of infiltration rates.
   c) Groundwater resources
   Introduction — Wadi Hanifa, Investigation of recharge to the alluvium water table — Other Wadis — Ad Dahi region — AzZilfi area — Dhruma plain — Wadi Al Atj area — As Sulaiy plain — Al Kharj plain — Wadi Nisah — Al Aflaj area — Minjur aquifer — Wasia and Riyadh aquifers — Ground

water potential of the various geological formations in area V — Water problems arising from the presence of the city of Riyadh on area V.

d) Water resources — General conclusions
Water Resources — Illustrations (Vol. 3)

3. Agricultural and Grazing Potential (Vol. 4) The report contains : Introduction — Relationships between climate and agriculture — Soils — Range lands — Present situation of agriculture — Current stock-raising situation and trends — Opportunities for agricultural development — Opportunities for animal production development — Proposals for the development of agriculture and animal production.
4. Appendix (6 volumes)
   a) Observation stations — Rainfall data (Vol. 5) Flood gauging (Vol. 6)
   b) Inventory of water points (processing of data, water analysis) — Drilling (Well summaries, grain size curves) — Pumping tests (Vol. 7).
   c) Drilling (Composite well logs) (Vol. 8).
   d) Geophysics (Vol. 9)
   e) Land surveying — Water table meaasurement — Map — Soil analysis (Vol. 10).

II- **Area VI**

(The Red Sea coast from the coast to the rift and from the Jordanian to the Yemen frontiers represent area VI).

This set of reports comprises reports on some pilot projects and the final reports.

a) **Pilot Projects**

1. Agriculture. Provisional Reconnaissance Reports. December, 1967.
2. Medina water supply. July, 1968.
3. Pilot project for range and animal production, March, 1969.
4. Pilot project for perennial water development of Thurayban. April, 1969.
5. Pilot project for Wadi Hali basin development. (Text and seperate Appendix). June, 1969.

b) **Final Reports.** May, 1970

The final reports are composed of five parts, in 10 volumes :

1. Summary of conclusions and Recommendations (Vol. 1) General program of work — Presentation of the report — Findings — Framework of development — Recommendations-Economic analysis and time — Schedule of the development projects for area VI.
2. Water Resources — Text (Vol. 2)
   a) Hydroclimatology — Rainfall and climatology — Hydrology.
   b) Utilization of surface water resources — Standard schemes proposed — Upland schemes — Developments involving storage and network — Developments involving spreading flood waters.
   c) Groundwater resources : Geological features — The plain of Jizan — Wadi Itwad — The Asir mountains — Al Birk plateau — Wadi Hali — Tihama and Sham — Wadi Al Lith — Wadi Sadijah — Tuweval (Wadi Sitarah) — Rabigh (Masturah area) — Wadi as Safra — Yanbu — Medina — Khaybar — The depression of Wadi al Jizl — Wadi al Ays — The Coastal region between Yanbuh and Duba — The mountains of north Hijaz — The coastal oases north of Duba — Wadi Ifal — Conclusions.

   Water Resources — Illustrations (Vols. 3 and 4).

3. Agriculture, Grazing and Fishing — Text (Vol. 5)
   a) Soil and land classification
   b) Range survey
   c) Livestock survey
   d) Present situation of agriculture
   e) Development of Red Sea fisheries
   f) Farm products marketing in area VI.

4. The People — Text

   Agricultural Development Potential (Vol. 6)
   a) Population and population trends in area VI
   b) Social structure and factors for change in area VI
   c) Possibilities of agricultural development
   d) Development objectives and programmes

   Illustrations (Vol. 7)

   Agriculture, Grazing and Fishing

   The People — Agricultural Development Potential

5. Appendix (3 volumes)
   a) Climatology — Hydrology — Water analysis — Drilling well summaries — Pumping tests — Lugeon tests (Vol. 8)
   b) Composite well logs (Vol. 9)
   c) Soil and fodder analysis — Marketing (Vol. 10)

C) Reports Prepared by PARSONS BASIL

Northern Zone and Nafud (Area I)

1. Area 1 — Planning and cost survey. July, 1965
2. An emergency area report for the Qasim, Wadi As Sirhan, Al Jawf and Sakakah. September, 1966.
3. The development potential (Vol. 1), September, 1968.
4. The agricultural resources (Vol. II). September, 1968.
5. The water resources (Vol. III). September, 1968.

D) Stanford Research Institute

(SRI, Menlo Park, California 94025. U.S.A.)

Special reports have been prepared by Stanford Research Institute (SRI) for the Ministry of Agriculture and Water, Kingdom of Saudi Arabia. These include 5 special and a summary report published in January, 1971 (SRI Project ECH-8680). The reports deal with the agricultural development, animal production, marketing and social considerations.

Special Report No. 1
James L. Mackin

Evaluation and use of area resources surveys for agricultural development in Saudi Arabia. 307 p.

Special Report No. 2
Howard B. Sprague

Improvement of livestock production by Bedouin nomads on semi-desert rangelands of Saudi Arabia. 48 p. and Apps.

Special Report No. 3
Clarence J. Miller and **Bruce B. Barber**

A program for the improved marketing of agricultural commodities in Saudi Arabia. 108 p.

Special Report No. 4
Earl O. Heady

A synthesis of policies to attain the goals of the agriculture sector plan of the Ministry of Agriculture and Water. 83 p.

Special Report No. 5

Ibrahim A. Darrab, Abdulkareem O. Alkharashi, Abdul Rehman M. El-Omran, Mohammed M. Shams and **Soliman O. Nather**

Selected commodity situations in Saudi Arabia, with views on policy alternatives. 227 p.

Summary Report :

Essentials of an agriculture development plan for Saudi Arabia. 29 p.

E) Reports Prepared by Sir Williams Halcraw and Partners — London, 1972

Irrigation Development in the Wadi Jizan, Saudi Arabia-Feasibility study and designs for Irrigation Schemes.

The report, prepared by Sir Williams Halcraw and Partners, comprises a main report, supported by 6 annexes.

Main Report AGL : SF/SAU 18-Technical Report

Annex 1 — Soils and land classification.

Annex 2 — Land tenure and water rights.

Annex 3 — Agriculture and livestock.

Annex 4 — Engineering

Annex 5 — Economic appraisal

Annex 6 — Soils and land classification maps, and project drawings.

The report is endorsed by FAO and is issued as Technical Report No. 1 in the schedule of reports applicable to the project.

V — EXPLORATIONS AND EXPEDITIONS

V — EXPLORATIONS AND EXPEDITIONS

1. HISTORICAL REVIEW

The earlier travellers in the Arabian Peninsula were mainly explorers and diarists. They ventured to travel through Arabia under extremely adverse conditions. Some of them adopted Islam and made their travels to the holy cities and described the caravans to Mecca. Works of these travellers contributed a great deal to the geography of the Arabian peninsula. However, the majority of books written by these travellers contain the local names of plants and animals as well as the description of many habitats. Mention should be made of the role played by the Moslem writers on the geography and botany of the Arabian peninsula. Their works have been translated to western languages and formed the guide to many western explorers in Arabia.

Though the earliest travellers to Arabia were explorers and diarists, yet their successors included plant and animal collectors. Some of these collections have remained up to the present day as highly valuable sources of our knowledge of the natural history of the area.

It is not intended here to give a full account of the expeditions and explorations of Arabia, but to show how far the area attracted many geographers, botanists and students of natural history. A chronological list of the principal travellers, collectors and botanists who contributed towards the knowledge of the geography, ecology and natural history of the Arabian peninsula, particularly the area occupied by Saudi Arabia.

The Arabian peninsula attracted the travellers since olden times and it is still attracting them. Alexander the Macedonian called it *Eudaimon Arabia* while the Roman knew it as Arabia Felix and the Europeans in the middle ages called it Happy Arabia, L'Arabie heureuse, Das glückliche Arabien. For them, Arabia was considered the land of myrrh, balsam and incense. The Greek divided the peninsula into three parts : Arabia Felix to the south, Arabia Deserta in the centre and Arabia Petrae to the north.

Perhaps the starting point for us is the History of Herodotus, written in the mid-fifth century B.C. Agatharchides of Cindos (*ca* 170-100 B.C.) drew up a treatise on the Erythraean Sea (Red Sea) in five books. He is the first author to describe the wealth and prosperity of the Sabaean Kingdom of southwestern Arabia, so that the name "Arabia Felix" came to refer to that part of the peninsula. In the mid-first century B.C., Diodorus Siculus wrote a monumental "Library of History" in forty books, of which some are preserved Book II contains an account of the wild animals, plants and minerals of different parts of Arabia.

The Roman Emperor Caesar Augustus, trying to wrest the incense trade monopoly from the hands of the Himyarites with force, sent a military force under the command of Aelius Gallus, Epach of Egypt, to Arabia. He landed in 24 B.C. at Leuke Kome, (White village, perhaps Al-Haura north of Yenbou) and reached Najran and took it. Later he was forced to return cursing all who had induced him to invade this land. The Greek historian Strabo (born *ca* 63 B.C.) wrote a comprehensive geographic work with many facts about Arabia.

The Graeco-Egyptian navigators were venturing out of the Red Sea and coasting towards India, along the south shore of the peninsula. The collected information were wrote by an unknown geographer as *Periplus Maris Erythraei* "Periplus of the Red Sea" late in the first century after Christ. Pliny (23-79 A.D.) wrote about tribes, towns and villages of Arabia.

About a century after Pliny, the mathematician and astronomer Ptolemy of Alexandria (Claudius Ptolemaeus) undertook to make an atlas of the habitable world. He gave a map of Arabia with enumeration of one hundred and fourteen cities or villages in Arabia. Sprenger demonstrated this map in 1875 in his masterly treatise on the "Ancient Geography of Aarbia". Though cities were not located in their correct location, the persistence of names of these cities gives an idea about the effort of Ptolemy at that time. Macoraba (House of Lord, an archaic name of Mecca) was given by Prolemy, Dumaetha must be the mediveal Arabian Daumet, which is today the chief village of the great oasis of Jauf. Hejr, famous in the "times of ignorance" as the seat of a kingdom, and now Medayin Salih, is Ptolemy's Egra. Yatrippa placed on ptolemy's map inland from Iambia (Yenbou), is Yathrib which is El-Medina. Ptolemy showed some rivers in the peninsula, which might be wadis flooded with water, e.g. Wadi Fatima might represent the ancient Baetius given by Ptolemy.

Since the birth of the Islam, countless moslems have sallied forth for the pilgrimage. Highly organized caravans crossed the peninsula. Arabia has become such an object of the world's attention as she was never before. The Muslem writers wrote a lot about the geography and topography of the peninsula. They described the caravan routes. Till 1000 A.D., many works appeared, among those are of Al-Hamdani, Ibn Hauqal, Istakhri, Moqaddassi and others.

In 1328, Ibn Batutah after pilgrimage, visited Yemen, Dhofar, and Oman. He may be reckoned the first explorer of Arabia, the first to test geographical traditions with his eyes, or by the examination of local native witnesses.

Here, one must put down a clear fact, which has been masked by many Westerners, that the western knowledge in many fields depended to a great measure on the works of Muslems. I do not deny the role of the Greek in many fields of knowledge, but there is no doubt that Muslems have played a major role in the development and progress of many scientific fields. One may state that full translations of the earliest known Muslem studies did not appear till near the middle of the nineteenth century. However, western scholars who travelled through Arabia learned Arabic and adopted Islam even temporarily. This means that they were able to go through the Muslem works written in Arabic. In 1592, the Book of Climate of Idrisi had been issued from the Medicean Press. This was the abridgment of Idrisi, which was translated into latin by two maronites, and published in 1619 in Paris, under the title "Geographia Nubiensis". D'Herbelot, through his "Bibliotheque Orientale" in 1697 made the west aquainted with most of the muslem authors.

Some of the Muslem works dealing with the geography of Arabia have been translated and edited by many Europaeans since the early decades of the eighteenth certury till now. As examples of these works may be mentioned those of :

Al-Idrisi, Géographie d'Edrisi, tr. and ed. by A. Jaubert. Paris 1836-40

Al-Istakhri, by H.O. Mordtmann. Hamburg. 1845, also :

Viae Regnorum Descripito Ditionis Moslemicae-Auctore Abu Ishak al-Farisi al-Istakhri ed. by M.J. de Goeje. Leyden. 1927.

Abul-Fida, Géographie d'Abul Feda, tr. and ed. by M. Reinaud. Paris. 1848.

Ibn. Batutah, The travels of Ibn Battuta 1325-1354. by C. Defreney and B.R. Sanguinetti. Paris. 1853-59.

Al-Moqaddasi, by C. Lestrange. London. 1886. Also : Descriptio imperii moslemici, ed. by M.J. de Goeje. Bibliotheca Geographorum Arabicorum. Leyden. 1906.

Yakut, Jacut's Geographisches Wörterbuch, ed. by F. Wüstenfeld. Leipzig. 1866-1870.

Al-Hamdani, Geographie der Arabischen Halbinsel, ed. by D.H. Müller. Leyden. 1884-1891.

Ibn khordadbeh, Kitab al-Masalik wa'l-Mamalik (Liber Viarum et Regnorum) ed. by M.J. de Goeje. Bibliotheca Geographorum Arabicorum. Leyden. 1889.

Yakubi, Les Pays, tr. by G. Wiet. Cairo. 1937.

Ibn-Hauqal, kitab Surat al-Ard (Configuration de la Terre) tr. and ed. by J.K. Kramers and G. Wiet. Paris. 1964.

In this respect, mention may be made of the Muslem authors who wrote in botany and agriculture since the second century after Hijrah (8th century A.C.). Among those are : Al-Nadhr bin Shomail (... 204 A.H.), Moammar bin Al-Mothanna, Abu Obeida (114 — 210 A.H.), Said bin Aws Al-Ansari, Abu Zeid (122 — 215 A.H.), Ahmed bin Daoud, Abu Hanifa Al-Dainawary and Abdullah bin Quraib, Abu Said Al-Osmoei (128-216 A.H.). The book of Al-Ansari on "Plant and trees" was published by Nagelberg in 1909. The manuscripts of Al-Dainawary were verified by Hamid Allah (1970) and it was found to comprise the names of 1200 plants.

From the book of Al-Osmoei, verified by Al-Ghoneim (1972), I have learned why the *Markh* plant was given the lȁtin name : *Lepatadenia pyrotechnica*. Al-Osmoei mentioned the use of the fibers of this plant in producing fire by the flintlock and the stone; *Pyro* means fire.

The role of Muslem herbalists is still effective nowadays. Muslems as Ibn El-Bitar, Ibn Sina and Al-Antaki contributed a lot to the knowledge of medicinal plants and their use in curing diseases.

As we return to the expeditions to Arabia, one may mention that as early as 1487 Peter de Couillan, commissioned by King John of Portugal, found his way overland to the Red Sea, and skirted its coasts, calling thrice at Aden.

In the year 1500, Ludovico de Varthema (1465-1517), a Bolognese adventurer, sailed from Venice to Alexandria. After a short stay in Cairo, he sailed along the coast to Beirut and eventually made his way to Damascus, where he spent two years studying Arabic. On April 8, 1503, maesquerading as a Syrian, he joined a pilgrim caravan bound for Mecca, De Varthema was the first to describe the rites of pilgrimage in a western language. He visited Aden and travelled extensively in Yemen. After return to Europe, he wrote a book in Italian in 1510.

In 1508 the new-found sea-way round the Cape brought Portuguese ships to the Arabian shores, provided with charts made by Muslems as those of the "Pilot Omar" which were used by Afonso d'Alboquerque.

One of the earliest collectors of plants and explorers is Leonhard Rauwolff (1540-1596) who journeyed through Arabia, Palestine, Syria, Mesopotamia and Armenia during 1573-1576. He wrote a book in 1583. His plants, deposited in Leyden, were examined and published by J.F. Gronovius in the latter's Flora Orientalis (1755).

Arabia was visited by several travellrs, among them P. della Valle in 1658-63. In 1680, Joseph Pitts, an English sailor and prisoner of war, became a Muslem and accompanied his Algerian master to Mecca. He described the Kaabah and wrote an account of life among the Muslems when he returned to England. Pitts published his book in 1704.

On January 4, 1761, a party of five individuals, all expert in some science, representing the Danish Expedition dispatched to Arabia. Those are :

1) Forsskål, a Swede by birth and a pupil of the great Linnaeus, was a physician with special knowledge of botany.
2) Christian Carl Kramer, a surgeon and zoologist.
3) Friedrich Christian von Haven, a philologist and Oriental scholar.
4) George William Baurenfeind, an artist.
5) Carsten Niebuhr, a lietenant of engineers, a mathematician and practical surveyor.

With them went an ex-hussar, the Swede Berggren, as servant.

The Danish party arrived Egypt on September 26, 1761 and spent almost one year in the country where Forsskal collected many plants. On October 29, 1762, they arrived off Jeddah in a pilgrim ship. During their stay in Jeddah, Forsskal collected many plants and sent collections of seeds to Europe. Niebuhr mapped the city and recorded the temperature at hourly intervals for some days. Perhaps these records are the first climatic records in the area; tables of these data are given in Niebuhr's book.

The party left Jeddah on December 19, 1762 with a ship towards south where they landed in Qunfudhah. They collected plant and animal specimens from Tihama and the mountains. Proceeding to the south the party gathered a lot of information and numerous specimens. On May 25, 1763, the party lost their Arabist von Haven in Mokha. Forsskal met his death in Yerim on July 13, 1763. The rest journeyed to Hadramout, Oman and Muscat then to India. Niebuhr returning alone from India, after the death of his companions, landed once more in Arabia. He was at Muscat in January, 1765 and went up the Arabian Gulf. He returned home overland by Persia, Mesopotamia, Syria, Cyprus, and Asia Minor. Niebuhr died on April 29, 1815 in Meldorf at the age of 82. The narrative of his travels was published in German in 1772, and in French a year later. A greatly curtailed English version was issued in 1792. The collections of Forsskal, in Copenhagen, were published by Niebuhr in 1775, as "Flora aegyptiaco-arabica", later commented upon by C. Christensen (1922) and elaborated in part by M. Vahl in his "Symbolae Botanicae" (1790-4).

Forsskål left after his death 12 boxes full of collected material other than those already sent from Suez, Jeddah and other cities. Specimens were sent to Copenhagen, Uppsala, London, Paris, Leyden and Montpellier. Niebuhr mentioned in his writings that 800 different plant species were collected from Arabia.

Among the famous travellers is the mysterious Spanish Domingo Badia y Leblich, alias Aly Bey. He learned Arabic and assumed the identity of a scion of the House of Abbas. Aly Bey began his travels in North Africa and journeyed from Morocco to Cairo; providing detailed description of the countries along the way. In Cairo, Aly Bey joined the pilgrim caravan to Mecca, arriving in the Holy City on January 23, 1807. He was able to gain access to the inner chamber of the Kaabah and was given the signal honour of sweeping its floor. After returning to Spain, he undertook another mission to the Middle East where he died in Aleppo in suspicious circumstances. In his books published in Paris (1814) and London (1816), Aly Bey contributed a great deal to the geography, geology, botany and climate of Hijaz.

In 1810, Ulrich Jaspar Seetzen, who for twenty years had trained himself in Germany to be an eastern explorer, visited Arabia. He was a botanist and a most learned Arabist, who spent some seven years in eastern lands. He adopted Islam temporary and was qualifying as a darwish in the character to Hajji Musa, a physician. Seetzen journeyed in Transjordan in 1805-8, and in 1810 went to south-western Arabia. The account of his travels was published in 1810 in two publications and in 1854-9 in four volumes edited by F. Kruse.

Giovanni Finati visited Mecca in 1814 and his writings were published by W.J. Bankers (1830) in London.

Johann Ludwig Burckhardt (1784-1817), a Switzer of Basle, was one of the eminent travellers in the area. He adopted Islam and learned the Arabic language. For two years (1810-12) he travelled in Syria, Lebanon and Palestine, going on to Cairo and Nubia. Then in 1814 with the name Ibrahim ibn Abd-Allah, on a pilgrimage to Mecca, he explored Hijaz. Burckhardt had the advantage of an extended stay in Mecca for a period of three months. He mapped the city, gathered information about virtually unknown southern and eastern parts of the Arabian peninsula and went to Medina, where he stayed another three months, amassing a great deal of valuable information. In 1816 he ascended mount Sinai then returned to Cairo where he died at the age of 33. Burckhardt discovered Petra, the fabulous rock-hewn city in Jordan. Numerous botanical notes are included in his "Travels in Syria and the Holy lands" (1822), "Travels in Arabia" (1830) and three other books published in 1830, 1831, and 1835. His "Notes on the Bedouins and Wahabis" appeared in 1931 in the Arabian Journal published by Sir William Ouseley.

During that period many Muslem writings have been translated to Western languages. Among these may be mentioned the "Jihan Numa" of Mustafa ibn Abd-Allah, commonly called Hajji Khalifah or Katib Chelbi, author of the great encyclopaedic work of which D'Herbelot based his "Bibliotheque Orientale". C. Norberg has translated this book in 1818.

In 1819, Captain George Foster Sadleir crossed the peninsula from the Arabian Gulf to the Red Sea. He gave good descriptions of Nejd and the eastern part of the peninsula. His narratives were published in Bombay in 1866 as "Dairy of a journy across Arabia."

Eduard Rüppel, German scientist, travelled from 1822 to 1827 in Nubia, Sennaar, Kordofan and Arabia, collecting geographical, geological and climatological data. He published his observations upon returning to Germany (Reise in Nubien, Kordofan und Arabien 1822-1827. Frankurt 1829), He visited Jeddah for a second time in 1831 and collected more information which was incorporated in his "Reise in Abyssinien 1831-1835, Frankfurt 1838."

C.G. Ehrenberg (1795-1876) travelled in south-western Arabia in 1825. His plant collections and those of F.W. Hemprich (1796-1824) were deposited in the Botanical Museum Berlin-Dahlem. Among the publications by Ehrenberg or by him and Hemprich jointly, mention should be made of the "Symbolae physicae" (1828, 1900).

In 1831, N. Bové (1802-1841) collected plants in 1831 from Egypt and Yemen and in 1832 From Sinai. His collections were elaborated by J. Decaisne and published in the "Florula Sinaica" (1834-35) and in a second paper (1835).

P.M.R. Aucher-Eloy (1792-1838) journeyed and herborized in many Middle Eastern countries. In 1838, he travelled to Muscat where he explored the Jebel Akhdar. His collections have been published by de Candolle, Boissier and by Jaubert and Spach. He himself published "Relation de voyage en Orient" (1843).

J.R. Wellstedt (1805-1842) as a naval officier surveyed the Gulf of Aqaba (1830), the southern coast of Arabia (1833) and Oman (1835), he collected a large plant collection from Sinai.

W. Schimper (1804-1878) herborized in Egypt in 1834, in Sinai in 1835 and in Hijaz in 1836. His plants are at Kew and some of them have been published in A. Richard's Tentamen Florae Abyssinicae" (1847-51).

T. Kotschy (1813-1866) was among the most eager botanists of the Middle East. He journeyed in many countries of the Middle East and collected thousands of plants. He edited in 1865 a collection by an unknown

German physician who herborized in Hijaz and Asir in 1830-40 while accompanying the Egyptian army.

The French botanist, Paul Emile Botta (1802-1870), physician to Mohammed Ali, and commisioned by the Museum of Natural History of Paris, travelled through the highlands in Yemen in 1837. His important collections in these areas have been edited by J. Decaisne in his "Plantes de l'Arabie heureuse" (1841).

The Bavarian Adolph von Werde, after a stay in Egypt, assumed the name and the character of a pilgrim to the famous tomb of the saint Hud, known to lie in the Hadramaut. He travelled to Jeddah, sailed for Aden, and made his way inland from Mokalla towards Hadramaut on June 26, 1843. Ten years after the death of von Werde, Baron Heinrich von Maltazen, who had made the Mecca pilgrimage in disguise in 1860, and since occupied himself with Arab studies, issued Werde's journal (1870) in full, with map, inscription, notes and a vindicatory preface, but no sketches. The map was reissued in a revised form, in 1872, in Petermann's "Mittheilungen".

J.R. Roth (1814-1858) visited Sinai, Palestine and Lebanon in 1837 and Aden in 1847. Part of his collections was published by J.A. Schenk in "Plantarum species" (1840) .

A. Figari (1804-1870), who explored Egypt for thirty years, herborized in Sinai in 1836-7 and again in 1847 and around Mecca in 1849. His plants are in the Herbarium of Florence and were elaborated by Webb in his "Fragmenta Florulae aethiopico-aegyptiacae" (1854).

In 1845, George Augustus Wallin travelled in North Arabia in disguise as a learned Muslim Sheikh, Hajji Abdul-Moula. He was a distinguished Arabist. In 1848, Wallin made another trip to Arabia. The report of his first journey was read to the Royal Geographical Society in 1852 and appeared in print in 1854, two years after the traveller's death. His observations added a lot to the knowledge of the geography and sociology of the northern part of Arabia. His writings were translated to Arabic by Samir S. Shebaily in 1971.

In 1846, M.P. Edgeworth collected a small plant collection from Aden, but with several new species. T. Thomson (1817-1878) in 1851 and later in 1872, together with Sir J.D. Hooker (1817-1911) herborized in Aden.

The most famous Western traveller to Arabia is Sir Richard F. Burton, who in 1853 set off on the Pilgrimage, his knighthood and his fame as the translator of the Arabian Nights still far in the future. He visited Mecca, disguised as an Afghan holy man. He crossed Hijaz with the

pilgrim's caravans. Burton produced one of the greatest travel books "A personal narrative of a pilgrimage to Al-Madinah and Meccah".

On June 16, 1862, William Gifford Palgrave started his journey to North and East Arabia from Maan towards Jauf, Hail, Burayda, Riyadh, Hofuf, Bahrain, Qatar, Oman and Sharika. He gave instructive information on the geography, hydrology of the area as well as the sociology of the inhabitants. His writings were published in two volumes (1862-63).

In 1876, Charles M. Doughty left Damascus on November 13 to Arabia. His "Travels in Arabia Deserts" is a classic of literature as well as of travel. It includes useful information on the geography and biology of the northern part of the peninsula. Doughty prepared a map for such part which was presented to the Royal Geographical Society in London in September 1883.

The Dutch Arabist Snouck Hurgronje spent a year in Mecca in 1884. His two-volume work on the history and ethnography of Mecca is the classic scientific account, and a mine of information about all aspects of the Hajj.

George A. Schweinfurth (1836-1925), one of the most eminent explorers of Arabia and north-eastern Africa, after herborizing in the Lybian Desert in 1874 and around Aden and the south-eastern coast of Arabia in 1881, set out on a journey in 1889 *"In memorian divi Forskalii"* He proceeded along the Tihama coast and climbed Jebel Milhan, Jebel Burra and the western escarpment of the Haraza Mts. His collections were deposited at the Berlin — Dahlem Botanical Museum and only part has been published. One of his several publications is "Sammlung arabisch-aethiopische Pflanzen" (1894-9).

At about the same time (1887) A. Deflers (deceased 1921) travelled widely through the Haraza Mts., the northern and southern ranges of Yemen, and the adjacent inner plateau. His plants are preserved in the Museum d'Histoire Naturelle in Paris. The results of his journeys were published in many books.

An eminent explorer of the oriental flora was I.F.N. Bornmueller (1862-1948), who traversed the whole of the Near East and wrote about the plants of the area.

Among the explorations of Hadramaut those by L. Hirsch (1893), J.T. Bent and W. Lunt (1893-5) may be mentioned. Southern Arabia and Socotra were visited by O. Simony and St. Paulay (1898-9), Aden by W. Hein (1901); their plant collections have been published by J.G. Baker (1894), F. Vierhapper (1907), E. Blatter (1919-36) and O. Schwartz (1939) (See part 2).

In the last decades of the nineteenth century many westerners journeyed through Arabia. Their writings contribute a great deal to our knowledge of the geography of the peninsula. Some of them embraced Islam and visited Mecca. Among these may be mentioned the German Edward Nolde who traversed the Nafud, the French Charles Huber and Julius Eutig who journeyed together through central Arabia and the Nafud in 1883.

Lady Anne Blunt published her journey with her husband in 1881 in two volumes. This book contributes to the knowledge of Nejd and their inhabitants at that time. Parts of this book are translated to Arabic and published in Riyadh in 1967.

During this period many scholars visited the southern part of Arabia e.g. Leo Hirsch who was an archeologist and a profound arabic scholar visited Hadramaut in 1893.

Theodore Bent, his wife, the Indian Moslem surveyor Imam Bahador Sharif and his staff, a botanist William Lunt sent from Kew and an Egyptian naturalist formed a party journying in south Arabia in 1897. Imam Sharif's map is a better suvey than those obtained before in other parts of Arabia. Lunt's notes on the flora served to supplement and check the valuable treatise on Hirsch's collections, contributed by Schweinfurth.

In 1904, David George Hogarth wrote his valuable book "The penetration of Arabia". It gives a record of the development of western knowledge concerning the Arabian peninsula. It contains many maps and illustrations and may be followed a guide, to a large part, of the literature on Arabia in Western languages.

The desert of Nafud was explored by the Czech scholar and explorer, Alois Musil in 1909. His six volumes cover the northern portions of the peninsula in a detailed fashion. His plants were identified and edited by J. Velenovsky (1912, 1923).

H. St. John B. Philby went to Arabia during World War I and in the following forty years he travelled farther and was first in more places than any other explorer in the history of the peninsula. His books are freighted with information that has stood the scrutiny of later investigators with the time and training for more specialized studies.

B.T. Thomas crossed the Rub' al Khali in 1926, 1928 and 1930-1.

Extensive plant collections were made in southwestern and southern Arabia in the years 1927-8, 1931, 1934, 1939 by C. Rathjens with or without H. von Wissmann, or by the latter together with D. von der Meulen.. The material has been edited by O. Schwartz (1934 and 1939) (see part 2).

Wilfred Thesiger recorded his magnificant feats of travel in the sand and steppes of southern Arabia in his most fascinating book "Arabian Sands". This book was translated to Arabic and published in Beirut.

What has been written in the foregoing pages, though an incomplete treatise, gives an idea about the numerous writings concerning Arabia I believe that there is much to be added and hope that a complete survey of the writings, particularly of the Muslem scholars, will be prepared.

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APPENDIX

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